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AUTHOR Martin, Robert F.
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ABSTRACT

The theory of and research on the application of operant procedures to the college classroom is reviewed. Practical limitations of these procedures and shortcomings of this research are discussed. Covered in this paper are: (1) theoretical foundations; (2) operant foundations in education; (3) research on programed instruction; (4) the effectiveness of operant applications; (5) variables in applications; (6) research implications; (7) applications in higher education; and (8) a conclusion and implications for the future. (Author/KJ)

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Toward a Conceptualization of Learning Processes in the College Classroom I: A Review of Operant Research

Robert F. Martin[1]

University of Denver

With the increasing influence of operant theory in psychology, there has been intimation of its use in the classroom (cf., e.g., Skinner, 1965 and below). Recent research which has focused on the college classroom has become frequent enough to justify a review. This paper is intended to fill the need for a review of the research on applications of operant techniques in the college classroom. In addition, the theory, both from the laboratory and from the educational setting, is juxtaposed with this research review, so that educators and researchers may be provided a conceptual base for their efforts.

A survey of the indexes for Psychological Abstracts through 1958 yields no references by title to applications of techniques derived from the operant "camp" of behavioristic psychology to the college classroom. This lack of research on teaching was even more general, however; as Beck and Shaw (1960) have observed:

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The study of the psychology of teaching is apt to involve disappointment. The great number of studies in human learning generate the expectation of a speedy introduction to important principles of practical training. Nevertheless, it is apparent that, although a great deal is known about the many variables and conditions that affect learning, little is known about applying these to promote efficient training [p. 543].

Beck and Shaw's statement requires some modification because of the work in the decade since it was made. During this period, there has been much effort in attempting to extend the methodology and principles of operant conditioning from animal laboratories to "real, human" problems. This endeavor has been primarily within the "Skinnerian school" and is manifested in education by "programed instruction" and "teaching machines." The earliest effort in this area was made by Skinner and his colleagues (Skinner, 1958; Holland & Skinner, 1961), but was intimated by Skinner as early as 1948 (Walden Two).

In spite of the rapid growth in this area since Beck and Shaw's (1960) statement, there remains much reason for such "disappointment." As Lloyd and Knutzen (1969, p. 125) point out, the use of programed materials has been widespread, but has gone little beyond the use of programed textbooks (cf., Lumsdaine,

1964; Gagnè, 1965). Several volumes have dealt with programed instruction (cf., e.g., Lumsdaine & Glaser, 1960; Glaser, 1965; Calvin, 1969), yet applications to the college classroom of operant techniques have been limited almost exclusively to programed textbooks. This suggests a need to specify the foundations and mechanisms in such an application of the operant technology.

In this section, the attempt is made to (1) specify and elaborate the "theoretical" foundations of operant techniques; (2) review research on the variables of programed instruction and its implications; (3) briefly review the limited literature on specific applications which have been attempted; and (4) suggest the direction in this area.

"Theoretical" Foundations

The general procedures employed in the conditioning of operant behavior (i.e., behavior by which the organism modifies or manipulates his environment) have been set forth by many authors, but most extensively by the major proponent of this approach, B. F. Skinner (cf., e.g., Skinner, 1953; Skinner, 1963). In this section, the general procedures applied in operant conditioning are presented, as drawn from the sources noted previously. In addition, procedures which are similar and aimed

specifically at education and programed instruction are discussed.

Generally, five "steps" are delineated in the process of conditioning an operant (behavior); (1) the final desired outcome is specified; (2) the pre-conditioning level of this operant is measured; (3) the appropriate reinforcers, discriminative stimuli, and contingencies of reinforcement are specified; (4) a suitable "learning space" is established; and (5) the desired behavior is "shaped up" and brought under the control of the previously specified discriminative stimuli and contingencies of reinforcement. The order of these "steps" is not necessarily fixed. For instance, step (2) above may be better placed after (3) and (4) in specific situations; steps (3) and (4) might also be reversed where appropriate. In addition, the final behavior is assessed to determine to what extent the " desired outcome" was accomplished.

In specifying the "final desired outcome," the experimenter must define what behavior (specifically, operant) is to be the end-product of this conditioning. In defining the operant, the measures by which the success of the conditioning is determined are also specified. As an example, in a typical conditioning study, an experimenter may have decided to establish a color discrimination in a pigeon. In such a task, the pigeon is to exhibit an operant of pecking a key of only one color and not

another. In defining the final outcome, the experimenter also specifies the criteria of learning. That is to say, the measures whereby the operant is said to be conditioned or not are stipulated. In the present example, the experimenter may be satisfied that conditioning has taken place if the pigeon pecks the white key only 90% as often as the red in a 60 minute session.

In determining the "pre-conditioning level" of the operant, the experimenter is interested in the probability (or, operationally, the frequency) of the response in the organism's existing repertoire of behavior. In so doing, the "base rate" for this particular operant in the specific organism is defined, against which the final outcome of conditioning can be compared. In the example of conditioning a pigeon to discriminate between a red and a white key, this step is carried out by observing the frequency of the pigeon's key-pecking behavior prior to any experimental manipulations. In addition to determining the base rate of the operant in question, in this step the experimenter takes note of behaviors which could be components of a more complex operant (i.e., a "chain" of responses) which the experimenter might wish to establish in the behavior repertoire of the organism and for which the base rate is virtually zero. In the example of the pigeon color-discriminating, if the desired

operant were a circle turned in the clockwise direction before pecking the red key, the experimenter would note in the base rate determination those behaviors which were emitted frequently and could be components of the turning behavior, such as tilting the head in the clockwise direction.

The third step noted above is most complex and deals with "motivational" variables of learning, as well as, the physical limits of the organism. In specifying the appropriate reinforcers, the experimenter must be aware of or control the physiological state of the organism. "Motivation" for learning (performance) is typically operationalized by depriving the organism of some necessity of life (e.g., food, water), but not to such an extent as to impair the organism. Yet choosing, as a reinforcement of the food-deprived pigeon in the previous example, a pellet of dried meat would be inappropriate. In addition to reinforcement defined appropriately by deprivation, other types of reinforcers may be useful. Secondary reinforcers, when they can be observed or established for the organism, may be more appropriate in certain conditioning situations. (This is apparent in considering the complex behavior of students controlled by grades or "being right"; a point considered in greater detail below.) In the example of the color-discriminating,

clockwise-turning pigeon, many circles may be turned just to be able to peck the red key (the key becoming red only after n circles are turned by the pigeon).

In specifying the discriminative stimuli, under the control of which the experimenter wishes to being the operant, again the physiological limits of the organism must be recognized. To require the pigeon in the, by now well-used, example to discriminate between two shades of red, closely spaced on the spectrum, would be an impossible task to learn. In addition, the discriminative stimulus may vary in its appropriateness to the task. (This point can be better exemplified in considering educational uses of operant techniques discussed below.)

The specification of the contingencies of reinforcement includes two primary considerations: (1) the interval between operant termination and the presentation of reinforcement (termed "delay of reinforcement") and (2) the number of operants required prior to reinforcement ("schedules of reinforcement"). In this regard, the physiological limits must be considered: a delay of reinforcement of five minutes is likely to have little effect on the color-discrimination operant of the pigeon, yet a grade of 129/150 can have powerful effects for a student several weeks after the behavior has been emitted. Likewise, expecting a

pigeon to emit ten circle-turnings for the first reinforcement is unreasonable. Both the delay and schedules of reinforcement have been extensively researched in the laboratory (cf., Ferster & Skinner, 1957), and hence, the experimenter can readily find guide lines for this step. (This procedure when applied in the educational or thereapeutic setting has been termed "contingency management," by some authors; see below).

In establishing a "suitable learning space," the experimenter attempts to control as many as possible of the variables which may impinge on the organism and interfere with conditioning. In addition, the environment most conducive to learning is sought. This includes making the methods of response and reinforcement convenient to the organism. In the example of the discriminating pigeon, this is generally accomplished by utilization of an operant conditioning apparatus (so called, "Skinner Box").

Finally, the experimenter shapes up the specified operant by reinforcing successive approximations of the behavior. In addition, the behavior is brought under the specified discriminative (eliciting) stimulus and contingency of reinforcement. The "key" to success in this step, is in the utilization of small increments in moving from simple to complex behavior, in

bringing behavior under the control of specific (sets of) stimuli, and in establishing schedules of intermittent reinforcement.

Operant Foundations in Education

Several authors have delineated approaches to applying, to the educational situation, operant techniques similar to that discussed in the preceding section. Reviews by Gagné (1965) and Barlow (1962) represent and summarize such work.

Barlow has maintained much of the language of "Skinner's 'operant' psychology," yet taken it from the laboratory setting (as is exemplified in the preceding section) and placed the emphasis on the classroom. Barlow states,

> [T]he task of the teacher is to (1) determine the current discriminative repertoire and effective reinforcers for the potential students; (2) carefully specify the desired terminal behavior and conditions under which this behavior is appropriate; (3) evoke and reinforce typical current behavior that is relevant in order to "dipper" or "magazine" train the student; (4) carefully sequence SDs [discriminative stimuli] and reinforcement in order to shape the behavior of the student until the desired behavior is emitted in the presence of SDs typical of the natural practical environment in which the behavior is appropriate; (5)

complete the sequence in such a manner that the new behavior will be intrinsically reinforced and maintained after the sequence is completed [p. 403].

It should be noted that, in addition to some differences in the order of the steps outlined in the preceding section and Barlow's, there are some differences in emphasis (if not content). It should be helpful to indicate just how Barlow's scheme relates to the more general one outlined previously. Barlow's first point corresponds roughly to the third point in the general scheme outlined above, that is specifying the appropriate reinforcers, SDs, and contingencies. In addition, this step of Barlow's scheme implies the determination of base rates which is the second point in the general operant procedure. In addition to the third step of the general scheme, just noted, Barlow's second step implies (1) of the general scheme, specification of the desired final outcome. The "conditions under which this behavior is appropriate" can be taken as the relevant discriminative stimuli and contingencies of reinforcement. Barlow's third and fourth points may be seen to correspond with the fifth point of the general procedure, shaping and establishing contingencies. The fifth point of Barlow's scheme is implied in (5) of the outline of the general procedure: "intrinsically

reinforced and maintained" may be taken to correspond to "brought under the control of the previously specified discriminative stimuli and contingencies of reinforcement." Barlow's scheme apparently does not specifically consider step (4) of the general procedure for operant conditioning, the establishment of a suitable learning space. It is, however, implicit in Barlow's whole description and most clearly implied in (3).

Gagné (1965) has emphasized the importance of specifying the outcomes of conditioning and the conditions for the behavior to be emitted (Barlow's second step). In addition, to the necessity of this step apparent in the statement of the operant approach in the laboratory (step (1) in the general scheme), Gagné emphasizes some other and perhaps more practical considerations. To Gagné the specification of terminal behavior desired by the teacher is essential so that the "instructional designer" may know the nature of what is to be learned. Gagné elaborates on this point, stating that the "instructional designer" must know the nature of the terminal behavior so that he can correctly design the terminal stages of his program. This depends on the specification by the user of a program (teacher) of "what the learner is expected to be able to do" having gone through instruction. It is only with such a criterion that the success of the program can be measured. Clearly, this ter-

minal behavior must be specified as an overt performance in order to provide a suitable criterion. In addition to determining the terminal sequence of the program, Gagné points out that the specification of outcomes in overt behavior allows the programmer to make inferences about behavior modifications to be made through the program (pp. 23-24).

Gagné notes two more reasons for specifying the desired outcomes of conditioning in terms of overt behavior. One such specification allows the evaluation of the effectiveness of the program in comparison to pre-conditioning behavior, as well as comparisons of the effectiveness between programs. This is so because the specification of overt terminal behaviors meets the requirements of reliability and measurement. Finally, Gagné suggests that the most important function of specifying outcomes of conditioning is the provision of a basis for the shaping of behavior (cf. steps (3) and (5) of the general scheme above). Distinctions among the class of behavior to be established may serve as a basis for modifying previous patterns of behavior. Different classes of behavior require the application of different conditions for learning (p. 25). In Gagné's preceding treatment "user" and "educational designer" are distinguished. Often, however, it is the case that in the ad hoc use of

operant techniques in the classroom (the construction of a program or writing of a programed text), these two "technicians" are the same. Nevertheless, it should be emphasized that the specification of clearly defined end-products for the conditioning remain essential.

Gagné emphasizes one more role for the specification of outcomes or "defining of objectives;" this has to do with the role of reinforcement in applying operant techniques to human behavior. The matching of behavior to specified outcomes (i.e., "being correct") appears to be a powerful reinforcer of human behavior (Gagné, 1965, p. 26). However, Gagné adds that "reinforcement" has not been practically defined, beyond the conceptual definition that a set of conditions coincident or closely subsequent to a behavior which appears to increase the probability of that behavior is termed reinforcement. Reinforcement is then taken to mean, in programed instruction, the learner's matching of his own response production to a response which is indicated as correct (p.27).

So far, the discussion has been limited to Barlow's second point and to the additions suggested by Gagné. Skinner (1965) has written an article which suggests some further clarification of Barlow's outline and provides some additional translation

from the statement of operant procedure in the laboratory to the application of these procedures in the classroom. Skinner offers the following elaboration:

> An important contribution of [operant research] has been the so-called "programing" of knowledge and skills -- the construction of carefully arranged sequences of contingencies leading to the terminal performances which are the object of education. The teacher begins with whatever behavior the student brings to the instructional situation; by selective reinforcement he changes that behavior so that a given terminal performance is more and more closely approximated. Even with lower organisms quite complex behaviors can be "shaped" in this way with surprising speed; the human organism is presumably far more sensitive [pp. 6-7].

The notion, contingency, implies both reinforcement schedules and sequences of discriminative stimuli; behavior is brought under the control of both. As Barlow suggests, "weaning" from the program is essential also, so that the behavior is maintained by the appropriate schedules and reinforcers and discriminative stimuli in the "real world."

Reflecting the emphasis on specification of overt behaviors as the terminal outcomes of conditioning made by both Barlow and

Gagné, Skinner (1965) also emphasizes the equally straightforward (overt) function of the program (or teacher): "[T]he task of the teacher is to bring about changes in the student's behavior. His methods are equally conspicuous: he makes changes in the environment. A teaching method is simply a way of arranging an environment which expedites learning [p. 13]." This is the implication of the third and fourth points in Barlow's scheme, but it more clearly reflects the fifth point of the discussion in the preceding section on operant techniques in the laboratory, that is the establishment of a suitable "learning space." In addition to manipulation of contingencies of reinforcement and discriminative stimuli, an environment "conducive to learning" (i.e., a "learning space") is needed.

Skinner also suggests a dichotomy of the role which operant procedures play in the educational setting. As he views this role of "programming," the arranging of contingencies of reinforcement by the teacher to establish new forms of response, such as handwriting and verbal and non-verbal behaviors as in sports, arts, and crafts, are fairly straightforward. However, to arrange contingencies to bring existing behaviors under new stimulus controls, such as with intellectual and ethical self-control has not been so widely applied, but requires the application of

the same principles (1965, p. 13). This discussion corresponds roughly to Barlow's fourth point, but also incorporates part of Barlow's final point.

The second half of Skinner's dichotomy of the role of operant procedures in education completes the fifth step of Barlow's scheme and reflects the "motivational" aspects in the preceding treatment of laboratory operant techniques. Skinner emphasizes the role of schedules of reinforcement in suggesting that "a second kind of programing" results in the maintenance of the strength (or probability) of a student's behavior. The form of the response and stimulus control are not altered but the liklehood of response is increased. The introduction of new reinforcers or increasing the effectiveness of old ones can strengthen behavior, as in Skinner's example of providing a student better reasons for getting an education. He adds that another possibility is suggested by the experimental analysis of behavior: available reinforcers may be scheduled more effectively. Appropriate terminal schedules will yield a "motivated" student; "interested," "perservering," "curious," and "industrious"; but less stringent schedules are required first, in order to maintain the desired behavior at every stage. Skinner stresses that, "The programing of schedules of reinforcement is a promising alternative to the

aversive control which, in spite of repeated reforms, still prevails in educational practice" [1965, pp. 13-14].

At this point the "translation" of laboratory techniques of operant conditioning skills to be used in the classroom should be fairly complete. With the theoretical foundations of operant conditioning in education having been delineated, it is now possible to consider the relevant research on and programs of operant approaches in education.

Research on Programed Instruction

Conceptually, the operant conditioning approach to education can be considered under two major research questions. First, operant techniques (i.e., specific programs) can be compared with one another and with other educational approaches as to their effectiveness. Secondly, variables which may function within a program in relation to its effectiveness or some other measure may be of interest. Such variables might have to do with the program itself, such as size of increments of response required, number of items, nature of the reward; or variables which the learner brings into the learning situation, such as "intelligence," previous history of reinforcement, may be considered. Typically, these latter variables are indicated by correlational measures such as achievement scores and grade

point average (GPA). Before sampling the limited and generally poorly executed research in this area, some of the possible sources of the sparseness of this research are considered.

It appears very curious that an approach growing out of a history of fervent research and an advanced methodology for research (i.e., strict operationalism), an example of which is programed instruction, evidences such a dearth of research. Skinner (1965) suggests that this lack of research may be in part a result of a "tradition" of research in education, which is somewhat antithetical to that implied by the operant approach. That is, the contribution of operant research to the technology of education is in the analysis of reinforcement contingencies. Under the influence of Thorndike's work in the measurement of mental abilities, research in educational psychology has neglected causal relationships in the processes of instruction (pp. 16-19).

Skinner points out additional difficulties for research in this area, but these can best be considered in the discussion of the two research topics. However, before discussing specific research questions, the orientation of research in this area proposed by Skinner (1965) may be usefully presented:

> [I]n education, no matter how important improvement in the student's performance may be, it remains a by-product of specific changes in behavior resulting from specific changes in the environment wrought by the teacher. Educational research patterned on an experimental analysis of behavior leads to a much better understanding of these basic processes [p. 17].

The implication here, then, is that research employing traditional measures (e.g., GPA) is inappropriate; emphasis should be placed on the "learning environment" (e.g., schedules of reinforcement). In spite of this suggested emphasis, the research tends to follow the traditional approaches, as is seen in the following discussion. In the topics considered below no effort is made to comprehensively summarize research designs and "findings." The emphasis, rather, is to indicate the kinds of variables which have been of research interest, along with apparent limitations of such research.

The Effectiveness of Operant Applications

Although research in this area could conceptually center on comparisons of various programs, the bulk of this limited research deals with comparisons of operant approaches to traditional approaches in education. Skinner (1965) at once has emphasized

the need for such research and pointed out its limitations. In addition to knowing the successfulness of a program in bringing about the desired behavior or the successfulness of one program compared to another, it may be useful to know what changes are brought about in the student, perhaps in addition to those specified. Traditional experimental procedures (reliability, correlation) and formulation of designs (insight of the teacher) are not sufficient for assessing the effectiveness of a program with individual students and rarely have directly resulted in improved practices (pp. 16-17).

A study by Rawls, Perry, and Timmons (1966) compared "conventional instruction and individual programed instruction in the college classroom." Programed instruction here consisted only of a commercially prepared programed text, while the "traditional" approach of lecture and assigned readings provided the second condition. The material to be learned was the physiological section of an introductory psychology course. Subjects, 21 pairs, matched on variables of sex, age, IQ, and formal training in biology, were tested immediately after the completion of the topic, and, six weeks later, were retested. The authors conclude that the programed instruction resulted in better long-term retention. This is exactly the kind of

research, traditional in education, which was criticized above. The individual effects of the instruction are lost in group means; whereas the operant approach emphasizes the unique learning of an individual student.

A study conducted by McGrew, Marcia, and Wright (1966) evidences somewhat more research sophistication than that of Rawls, et al (1966). In an effort to control for the differential practice possible in designs which compare traditional with operant approaches, these authors employed a "branching program" (i.e., when S gives a correct answer, he skips subsequent repetitive frames). Using an analysis of covariance of the test performance of 66 undergraduates, the authors conclude "that sheer repetition of material, regardless of the medium employed, is a significant factor influencing the outcome of comparative studies [p. 505]." These authors imply that many of the studies comparing operant with traditional approaches to education have failed to control for possible differences in practice inherent in the techniques.

McMichael and Corey (1969) have also compared a traditional with an operant approach to teaching introductory psychology. Based on comparison of final examination scores, these authors concluded that the operant approach was superior. However,

more interesting than this conclusion is the general use of operant techniques beyond programed textbooks, known as "contingency management," which is considered more completely below.

Variables in Application

As noted earlier such research could take two tactics conceptually. The majority of the research deals with variables students bring to the educational setting. The information on the second research question, that of variables within the operant approach, has had an extensive history of laboratory research (cf., e.g., Skinner, 1957). Hence, in the application of the operant approach to education, much of this information is used rather uncritically.

Coulson and Silberman (1960) report a study in which some of these variables are discussed, yet the methodology Skinner has criticized above is used. Three independent variables were manipulated: response mode (multiple-choice vs. constructed response), increment between steps, and linear vs. branching. An analysis of covariance compared pre-test and criterion test scores of two subject groups. Among other conclusions, these authors report the superiority of small steps for learning and no differences for the other two variables.

Representative of research on variables which the student brings to the operant situation are studies by Doty and Doty (1964) and Flynn (1966). The variables delineated in the first study were "GPA, creativity, achievement need, social need, and attitude toward programed instruction [Doty and Doty, 1964, p. 334]." They indicate that GPA and "social need" are important variables in the success of programed instruction. In the Flynn study the effect of programed and "regular classroom procedures" were compared for "achievers" and "underachievers Flynn, 1966, [p. 390]." Flynn suggests that for "underachievers" the method has no effect on learning. For "achievers" operant techniques were superior.

Because of the nature of this research, only an indication of the sorts of questions which are of research interest has been presented in this section. In spite of the obvious need for such research in this area, there is apparently no comprehensive research program or literature. The need for and difficulty in such research has been succinctly summarized:
Research in teaching, of course, must not lose sight of its main objective: to make education more effective. But improvement as such is a questionable dimension of the behavior of either teacher or student. Dimensions which are more intimately related to the conditions the teacher arranges to expedite learning

must be studied, even though they do not contribute to improvement or contribute to it in a way which is not immediately obvious [Skinner, 1965, pp. 18-19]."

Research Implications

Although the literature discussed in the preceding sections appears to leave many issues unexplored and suffers from poor methodology, some implications can be drawn from it. With the current demands of society on educational systems, the time-effectiveness measures of teachers and programs have become critical. Demands on and costs of education appear to have far exceeded the "supply." If the application of operant techniques to education can help to alleviate this situation, either by increasing effectiveness of teachers and education or by reducing educational costs (by whatever measures either is to be judged), then there is a great need for research into and application of these procedures (cf., Williams, 1967; Gilbert, 1969).

The need for operant techniques in college application would appear to be even greater than for general education, if judged by the standards suggested in the preceding paragraph. One man's logic and preference for such an approach is evident in the following:

In maximizing the student's success, programed instruction differs from so-called trial-and-error learning where the student is said to learn from his mistakes. At best he learns not to make mistakes again. A successful response may survive, but trial-and-error teaching makes little provision for actually strengthening it. The method seems inevitably committed to aversive control. For the same reason, programed instruction does not closely resemble teaching patterned on everyday communication. It is usually not enough simply to tell a student something or induce him to read a book; he must be told or must read and then be questioned. In this "tell-and-test" pattern, the test is not given to measure what he has learned, but to show him what he has not learned and thus induce him to listen and read more carefully in the future. A similar basically aversive pattern is widespread at the college level, where the instructor assigns material and then examines on it. The student may learn to read carefully, to make notes, to discover for himself how to study and so on, because in doing so he avoids aversive consequences, but he has not necessarily been taught. Assigning and testing is not teaching. The aversive by-products, familiar to everyone in the field of education, can be avoided through the use of programed positive reinforcement [Skinner, 1965, pp. 14-15].

With the apparent demand for the application of operant techniques to higher education, it is disappointing to note what has been accomplished.

Applications in Higher Education

The literature which reports application of operant principles to the college classroom primarily are ad hoc attempts; "ad hoc" in the sense that a specific program is written when a specific need arises. In addition, these programs are typically limited in the application of operant principles; most of the literature sampled reports the use of programed textbooks or of teaching machines, which are limited to a specific course content. The principles derived from "operant psychology" appear not to have been nearly as widely applied to the college learning situation as is conceptually possible. Very recently, however, some authors have reported what appears to be movement in this direction. This general approach often is termed "contingency management."

Programing for college education (primarily writing textbooks) has covered a surprisingly wide range of topics and been carried on by a surprisingly wide range of "programers." Yet, the bulk of the work appears to be in introductory level psychology (cf. e.g., Barlow, 1962; Lloyd and Knutzen, 1969;

McMichael and Cory, 1969). Williams (1967) reports on a program in which operant techniques were applied to the undergraduate electrical engineering curriculum at Carnegie Institute of Technology. Williams concisely reviews the operant basis for the effort at Carnegie and the reasons for the interest in such an approach (see above). However, this program is limited to teaching machines and particular content areas, and hence does not offer anything of general interest in the application of operant procedures to the college classroom.

Two extensive efforts to utilize operant procedures in higher education are reported, which reflect wide interdisciplinary interest. Gilbert (1969) comprehensively reports on the role of programed learning in the "university instructional services" at Northeastern University. In this program the curriculum needs of undergraduates are referred by many departments to this service. Existing materials are appraised and new programs of instruction written and evaluated, where required. Here again, however, the use of operant principles is limited to the presentation of course content and so-called "hardware" (i.e., teaching machines and textbooks). Gilbert does not report the use of operant techniques to learning situations, other than content. A more limited but similarly

interdisciplinary approach (both with regard to content and designers) is reported by Jacobson (1962-1963) at Hamilton College. Here programs were written by individual members of departments of French, German, mathematics, psychology, and philosophy, under the auspices of the Fund for the Advancement of Education. Jacobson notes the same sort of reasons for the interest in applying operant principles at Hamilton College as those suggested by Gilbert and in the preceding section. The Hamilton effort is subject to the same limits as were pointed out for the Northeastern program.

Two efforts which go beyond the application of operant principles to course content alone are of particular interest. The course reported by Lloyd and Knutzen (1969) utilized operant principles in much more of the total educational situation than just a programed text (Holland and Skinner, 1961). The particular outline of the course is not important, but rather the procedure for the utilization of operant principles is of interest. Initially, the terminal behavior was specified for the students and the existing contingencies (discriminative stimuli and reinforcers) were evoked: students were told exactly what activities were required at what deadlines for each grade. Activities were "programed" in the sense that material completed

at one stage was prerequisite for the second. In addition, behavior was "shaped" in students by requiring greater initiative as the course progressed, and "weaning" was accomplished by bringing the behavior under the control of discriminative stimuli and contingencies of reinforcement outside the classroom setting (e.g., library study). Lloyd and Knutzen describe their aims as follows:

> The purpose was to arrange an environment for the student in which he would be performing many of the activities that psychologists perform. What he must do was specified at the beginning of the semester. Each activity was part of a sequence of activities which added up to a terminal performance that was equivalent to a given grade [p. 125].

In addition to applying operant principles to the classroom, these authors also utilized an operant approach to the analysis of the data: each student's cumulative record was plotted and considered. In such an approach, it has been observed that,

> The changes in behavior of the individual student brought about by manipulating the environment are usually immediate and specific; the results of statistical comparisons of group performances usually are not. From this study of the behavior of the individual student, the investigator gains a special

kind of confidence. He usually knows what he has done to get one effect and what he must do to get another [Skinner, 1965, p. 19].

The final example in this section is that of a second rather extensive application of operant techniques. This is an example of what has been termed "contingency management" and follows a program first suggested by Keller (1966). The innovative research question of McMichael and Corey's (1968) study was "to test whether contingency management techniques could be used to teach the subject matter of a standard textbook [p. 79]." In this contingency management approach, reinforcements and their schedules, as well as appropriate discriminative stimuli were manipulated by requiring students to complete one section to criterion before moving to the next. These authors used a "traditional" statistical design to compare terminal performances of control and experimental subjects, the latter performing better.

It appears too early in the "data collection" to appraise the application of operant principles to the college classroom. However, the "pilots" of Keller (1966), McMichael and Corey (1969), and Lloyd and Knutzen (1969) are encouraging. Some speculations as to the future and some possibilities of why

the application of operant principles in higher education has not progressed more rapidly are discussed in the conclusion.

Conclusion: Implications for the Future

Teaching is the expediting of learning. Students learn without teaching, but the teacher arranges conditions under which they learn more rapidly and effectively. In recent years the experimental analysis of behavior has revealed many new facts about relevant conditions. The growing effectiveness of an experimental analysis is still not widely recognized, even within the behavioral sciences themselves, but the implications of some of its achievements can no longer be ignored [Skinner, 1965, p. 6].

In spite of Skinner's conviction and in spite of the needs noted previously, operant principles are not being widely applied to higher education. Some possible reasons have been suggested and some other possibilities are apparent.

Williams (1967, pp. 378-379) has emphasized the large capital investment required for the "hardware." However, operant principles can be applied without utilization of expensive "hardware" (i.e., teaching machines). Investment of time and

effort on the part of "educational engineers" (teachers) are great, but only initially.

Two, more compelling, reasons for the failure to utilize operant procedures in higher education may be suggested. First, it does not appear that the literature on operant research in the laboratory has had wide circulation among educators. This lack of familiarity with operant principles may have resulted in few professors, in disciplines other than psychology, taking the interest or initiative to become familiar enough with this body of knowledge to be able to apply it. Wide dissemination of the basic operant principles and their channels of application may meet the problem. Secondly, there appears to be a "tradition" in education which opposes "manipulation" of individuals; part of the aim of American education is to produce "responsible, thinking" citizens. The operant approach has been attacked on such grounds, that it allows the subject no "freedom." This complex issue is more appropriately considered elsewhere (cf., e.g., Skinner, 1966).

The advantages of the application of operant techniques are both numerous and obvious to a thoughtful reader. A few summary observations however, should make firm this point. Gilbert (1969) has concluded:

As learning methodology, programed instruction promises to relieve the teaching profession of some of the drudgery that precludes a creative approach to teaching. Effective programed instruction actually represents the preservation of good teaching. The many real benefits from use of programed instruction cannot help but accrue to all providers and all consumers of education -- in fact, to all human beings concerned with the needs of education, in our own country and throughout the world [pp. 239-240].

A similar sentiment is reflected by Jacobson (1962-1963, pp. 51-52) and Skinner (1965) offers a somewhat novel addition to this viewpoint.

Confidence in education is another possible result of an effective technology of teaching. Competition between the various cultures of the world, warlike or friendly, is now an accepted fact, and the role played by education in strengthening and perpetuating a given way of life is clear. No field is in greater need of man's most powerful intellectual resources. An effective educational technology based upon an experimental analysis will bring it support commensurate with its importance in the world today [p. 19].

The conviction of those working with the application of the principles of operant conditioning based on the experimental analysis of behavior is perhaps typified by the following:

> It is always tempting to argue that earlier ideas would have been effective if people had only paid attention to them. But a good idea must be more than right: it must command attention; it must make its own way because of what it does. Education does not need principles which will improve education as soon as people observe them; it needs a technology so powerful it cannot be ignored. No matter how insightful the anticipation of modern principles in earlier writers may seem to have been, something was lacking -- or education would be much further advanced. We are on the threshold of a technology which will be not only right but effective [Skinner, 1965, p. 16].

References

Barlow, J. A. Note: Operant techniques applied to the teaching of introductory psychology. Psychological Record, 1962, 12, 401-403.

Beck, J., & Shaw, W. A. Learning and teaching; An analysis and characterization. Psychological reports, 1960, 7, 543-553.

Calvin, A. D. (Ed.) Programmed instruction: Bold new venture. Bloomington: Indiana University Press, 1969.

Coulson, J. E., & Silberman, H. F. Effects of three variables in a teaching machine. Journal of Educational Psychology, 1960, 51, 135-143.

Doty, B. A., & Doty, L. A. Programmed instructional effectiveness in relation to certain student characteristics. Journal of Educational Psychology, 1964, 55, 334-338.

Ferster, C. B., & Skinner, B. F. Schedules of reinforcement, New York: Appleton-Century-Crofts, 1957.

Flynn, J. T. The influence of programmed instruction upon learning in educational psychology. Journal of Educational Research, 1966, 59, 387-391.

Gagné, R. M. The analysis of instructional objectives of the design of instruction. In R. Glaser (Ed.), Teaching Machines and Programed Learning: II Data and Directions. Washington, D.C.: National Education Association, 1965. Pp. 21-65.

Gilbert, J. E. Programmed learning and university instructional services. In A. D. Calvin (Ed.), Programmed Instruction: Bold New Venture. Bloomington: Indiana University Press, 1969.

Glaser, R. (Ed.) Teaching machines and programed learning: II data and directions. Washington, D.C.: National Education Association, 1965.

Keller, F. S. A personal course in psychology. In R. Ulrich, T. Stachnik, & J. Mabry (Eds.), Control of Human Behavior. Glenview, Ill.: Scott, Foresman, Inc., 1966. Pp. 91-93.

Lloyd, K. E., & Knutzen, N. J. A self-paced programmed undergraduate course in the experimental analysis of behavior. Journal of Applied Behavior Analysis, 1969, 2, 125-133.

Lumsdaine, A. A. Educational technology, programmed learning, and instructional science. In E. R. Hilgard (Ed.), Sixty-third Yearbook, National Society for the Study of Education. Chicago: University of Chicago Press, 1964. Pp. 371-401.

Lumsdaine, A. A. & Glaser, R. (Eds.) Teaching machines and programmed learning: A source book. Washington, D.C.: National Education Association, 1960.

McGrew, J. M., Marica, J. E., & Wright, C. K. Branching program, text, and lecture: A comparative investigation of instructional media. Journal of Applied Psychology, 1966, 50, 505-508.

McMichael, J. S. & Corey, J. R. Contingency management in an introductory psychology course produces better learning. Journal of Applied Behavior Analysis, 1969, 2, 79-83.

Meichenbaum, D. M., Bowers, K. S. & Ross, R. R. Modification of classroom behavior of institutionalized female adolescent offenders. Behavior Research and Therapy, 1968, 6, 343-353.

Rawis, J. R., Perry, O., & Timmons, E. O. A comparative study of conventional instruction and individual programmed instruction in the college classroom. Journal of Applied Psychology, 1966, 50, 388-391.

Jacobson, J. The Hamilton College Experiments: Programmed instruction in mathematics, modern languages, logic and psychology. Transactions of the New York Academy of Sciences, 1962-1963, 25, 45-52.

Skinner, B. F. Freedom and the control of men. In R. Ulrich, T. Stachnik, & J. Mabry (Eds.), Control of Human Behavior. Pp. 11-20.

Skinner, B. F. Reflections on a decade of teaching machines. In R. Glaser (Ed.), Teaching Machines and Programmed Learning: II Data and Directions. Washington, D.C.: National Education Association, 1965. Pp. 5-20.

Skinner, B. F. The experimental analysis of behavior. American Scientist, 1957, 45, 343-371.

Skinner, B. F. Science and human behavior. New York: Macmillan, 1953.

Skinner, B. F. Teaching machines. Science, 1958, 128, 969-977.

Skinner, B. F. Walden Two. New York: Macmillan, 1948.

Staats, A. W. & Staats, C. K. Complex human behavior: A

systematic extension of learning principles. New York: Holt, Rinehart & Winston, 1963.

Williams, E. M. Innovation in undergraduate teaching. Science, 1967, 155, 974-979.

Footnote

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